THE SCOTTISH HORTICULTURAL RESEARCH INSTITUTE

SECOND ANNUAL REPORT 1954-1955

MYLNEFIELD, INVERGOWRIE, DUNDEE
Tel: INVERGOWRIE 441

WEST OF SCOTLAND UNIT
Auchincruive, Ayr
Tel: ANNBANK 293

1955

12 SEP 1955

THE SCOTTISH HORTICULTURAL
RESEARCH INSTITUTE

SECOND
ANNUAL REPORT
1954-1955

MYLNEFIELD, INVERGOWRIE, DUNDEE
Tel: INVERGOWRIE 441

WEST OF SCOTLAND UNIT
Auchincruive, Ayr
Tel: ANNBANK 293

1955

THE INSTITUTE'S MAIN LABORATORY AND ADMINISTRATIVE BUILDING

Contents

DIRECTOR'S REPORT 7

FARM AND PLANTATIONS 12

POMOLOGY 14

VEGETABLE CULTURE 19

CROP PHYSIOLOGY 22

PLANT PATHOLOGY 24

MYCOLOGY 28

WEST OF SCOTLAND UNIT (AUCHINCRUIVE) 29

THE NEW STRAWBERRY VARIETY "TALISMAN" 35

METEOROLOGICAL RECORDS 36

Governing Body

Professor J. R. MATTHEWS, M.A., F.L.S., F.R.S.E. — Chairman.

JAMES GILCHRIST, Esq.

D. LOWE, Esq., C.B.E.

Sir JAMES DENBY ROBERTS, Bt.

Professor J. M. ROBERTSON, M.A., D.Sc., F.R.S., F.R.I.C., F.Inst.P., F.R.S.E.

R. L. SCARLETT, Esq., C.B.E.

Major CHARLES J. SHAW-MACKENZIE, M.B.E., T.D.

D L. STORRIE, Esq.

Principal M. A. H. TINCKER, M.A., D.Sc., F.L.S.

Professor T. WALLACE, C.B.E., M.C., D.Sc., F.R.I.C., V.M.H., F.R.S.

J. H. WARNOCK, Esq., M.B.E.

Principal S. J. WATSON, M.Sc., D.Sc., F.R.I.C., F.R.S.E.

Major-General D. N. WIMBERLEY, C.B., D.S.O., M.C., D.L., LL.D.

Staff

‡Director : T. SWARBRICK, B.Sc., M.Sc., Ph.D.(Leeds).

Pomology :

‡C. A. WOOD, B.Sc., Ph.D.(Wales).
*Miss M. E. ACHESON, B.Sc.(Birm.), Ph.D.(Nott.)
M. M. ANDERSON, S.D.H., D.H.E.
W. FORDYCE, S.D.H. (On National Service).
†Mrs H. M. ROBERTSON, B.Sc.(St. A.).
*J. P. SUTHERLAND, S.D.H.

Vegetable Culture :

C. NORTH, B.Sc. Hort., M.Sc.(Reading), N.D.H.
L. H. FRITH, B.Sc. Hort.(Lond.).
*Miss G. PRIESTLEY, Dip. Hort.(Reading).

Crop Physiology :

T. SWARBRICK.
C. G. GUTTRIDGE, B.Sc. Hort., Ph.D.(Reading).
*G. L. HODGSON, M.A.(Oxon.), D.Phil.
J. SUNDERLAND.

Plant Pathology :

‡C. H. CADMAN, B.Sc.(Liv.), Ph.D.(Edin.), F.R.S.E.
Miss K. S. ANDERSON, B.Sc.(St. A.).
J. CHAMBERS, B.Sc.(St. A.).
A. G. FISKEN, B.Sc.(Edin.).
*B. D. HARRISON, B.Sc.(Reading), Ph.D.(Lond.).
*Miss M. MILNE.
*A. G. RICHARDSON, B.Sc.(Glas.).

Mycology :

T. SWARBRICK.
W. R. JARVIS, B.Sc.(Sheff.), Ph.D.(Lond.), D.I.C.

Genetics :

T. SWARBRICK.
*A. B. WILLS, B.Sc.(Birm.).

Laboratory Service :

*J. CATHRO.
*Miss A. BULLOCH.

* Appointed 1954/55. † Resigned 1954/55.
‡ Recognised teacher in the University of St. Andrews.

Meteorological Officer and Photographer :

J. SUNDERLAND.

Farm and Plantations :

L. S. GRAY, B.Sc.(Edin.), Manager.
W. R. S. BATCHELOR, Mechanic.
R. W. REID, Plantation foreman.
F. RITCHIE, Farm foreman.
R. D. TAYLOR, Glasshouse foreman.

West of Scotland Unit (Auchincruive) :

R. D. REID, Officer in charge.
Miss F. W. HIGGINS.
W. I. A. JACK.
K. C. McCONNELL, S.D.H.
Miss I. G. MONTGOMERIE, B.Sc.(Glas.), Ph.D.(Edin.).
A. M. SUTHERLAND, S.D.H.

Administration :

A. B. ROSS, A.I.A.C., Secretary.
†Miss D. EDDIE
Miss J. C. S. GORDON.
*Miss F. MILLAR.
*J. PERT.
*Miss S. RODGER.
A. P. THOMSON.
*A. RODGER, Caretaker.

* Appointed 1954/55. † Resigned 1954/55.

Director's Report

The outstanding event of the year was the occupation in November, 1954, of the new laboratory block at Mylnefield, a view of which forms the frontispiece of this Report. To the old farmhouse, gutted and converted, new east and west wings have been added, the whole comprising nine laboratories, a library room, and rooms for the Director and Secretary. Designs for a much larger building were, unfortunately, curtailed by restrictions on capital expenditure. Consequently the new building is already fully occupied and most of the temporary laboratories provided to meet the needs of the last few years remain in use.

The new laboratories are designed to accommodate two people comfortably. All are equipped with permanent benching and there is a variety of choice of moveable furniture. This consists of store cupboards, table-benches, and units of drawers and/or cupboards, the last designed to fit beneath tables or benches at the individual's convenience. Such an arrangement obviates the need for permanent fixtures in the laboratories and is proving a great asset. The furniture, of varnished Oregon pine, matches the rest of the woodwork in the building. It is anticipated that the approaches to the building will be completed in 1955.

Two other important events of the year were Mr R. D. Reid's visit to the U.S.A. and Canada in May and June and the release of the new strawberry variety Talisman in spring, 1955. Acknowledgment is due to the Agricultural Research Council for financing Mr Reid's tour, the itinerary for which was arranged with Dr George M. Darrow of the U.S. Department of Agriculture. In the course of six weeks Mr Reid managed to visit all the main strawberry growing areas and research centres concerned with strawberry breeding. He returned with much useful information on red core disease *(Phytophthora fragariae)* and June Yellows, some of which he reports below, and procured seeds of species and races of *Fragaria* that may be valuable as new sources of red core resistance. Regarding "Yellows," it is some comfort to know that breeders elsewhere are as puzzled and perturbed as we are by the increasing frequency of this trouble in strawberry breeding material.

When, three years ago, it was decided to begin multiplying the stock of seedling 6J4 in preparation for its release, Climax was not as severely affected by "Yellows" as it is to-day. The need for a new variety afterwards became acute and accelerated the more guarded course the Institute would have preferred to take. However, sufficient plants of the new seedling were raised from a virus-tested stock to make possible a distribution in spring, 1955. The stock was granted an "Elite" certificate by the Depart-

ment of Agriculture for Scotland, the first of such issued, making the progeny of the plants eligible for Special Stock Certification. This seedling, raised by Mr Reid at Auchincruive in 1946, has been named Talisman, and a short description of it appears later in this report. The demand for plants was overwhelming and the problems of devising an equitable distribution were of a much different order from those attached to producing the stock.

Had there been a wider choice of varieties equal to Climax the catastrophe that befell it might not have been so disastrous. In order to meet such a need, work on the selection and development of new seedlings has been accelerated and arrangements have been made for several of the more promising ones to be virus tested and propagated at Mylnefield. Decisions on the introduction of new varieties cannot be made hastily, and adequate field trials take time. It is hoped, however, that Talisman may be followed by other introductions during the next few years.

STAFF

Until recently the Institute's technical work at Mylnefield was divided between the Plant Pathology and Horticultural Botany Departments. Expanding programmes of work and increases in staff, however, made some reorganisation desirable. Plant Pathology still retains virus and entomological work as major interests but a separate Mycology section has been established. The Horticultural Botany Department has separated into departments of Pomology, under Dr Wood, and Vegetable Culture, under Mr North; while entirely new departments of Crop Physiology, Genetics and Laboratory Service have been formed.

The list of staff additions this year is a lengthy one. To Plant Pathology we welcomed B. D. Harrison, A. G. Richardson and Miss M. Milne. From his appointment, on 1st October, until 1st March, Mr Harrison continued working with Mr F. C. Bawden at Rothamsted Experimental Station, where he had held an Agricultural Research Council scholarship. He was awarded the degree of Ph.D. by the University of London for work on virus multiplication in inoculated leaves. Mr Richardson, who graduated from Glasgow University in 1954, was appointed on 1st January to investigate Capsid infestation of soft fruits. Miss M. Milne came on 1st May to assist with the department's laboratory and field work. By courtesy of the head of the Botany Department of Queen's College, Dundee, she attended University classes there this session.

Mrs H. M. Robertson, who relinquished her post in the Horticultural Botany Department in September, had been on the staff since July, 1951. She was an energetic and versatile worker who, in addition to her botanical research, assisted ably in the early development of the experimental fruit

plantations at Mylnefield. Her successor is Dr M. E. Acheson, previously an assistant lecturer in botany at Queen's College, Dundee. National Service claimed Mr W. Fordyce, and Mr J. Sutherland was appointed in July to fill this vacancy temporarily.

Vegetable breeding is now a major interest, and the Institute was fortunate in securing Miss G. Priestley as assistant for this work in the Vegetable Culture Department. Miss Priestley had been doing similar work for the D.S.I.R. at Christchurch, New Zealand.

Dr G. L. Hodgson, appointed to the Crop Physiology Department in November, came to us from the Department of Agriculture at Oxford, where he had been working on the autecology of the field bean *(Vicia faba)*. His colleague in the new department is Dr C. G. Guttridge, previously of Horticultural Botany. They share the part-time assistance of Mr J. Sunderland, formerly of the Meteorological Office of the Air Ministry, whose primary duties are those of meteorological officer and photographer to the Institute.

Genetical work is likely to play an increasingly important part in dealing with the problem of "Yellows" in Climax and other strawberry varieties. Mr A. B. Wills was appointed in January and has begun work on this urgent problem. He graduated from the Department of Genetics at Birmingham University and later studied at the Plant Breeding Institute, Cambridge.

Technical service is of growing importance to the research staff, and the Institute has already benefited greatly from having Mr J. Cathro as laboratory technician. Formerly chief technician and glassblower in the Chemistry Department, Queen's College, Dundee, Mr Cathro was appointed in December and joined by his assistant, Miss A. Bulloch, in January.

Progress at the West of Scotland Unit has undoubtedly been aided by the move to new quarters. The enlarged facilities and the impetus provided by Dr Montgomerie's mycological work have stimulated the development of improved and more rapid techniques of testing strawberry seedlings for red core resistance. During the year Mr R. D. Reid was promoted to Principal Scientific Officer and Mr K. C. McConnell, who previously held a temporary post, was appointed Assistant Experimental Officer. It was a pleasure to welcome Mr W. I. A. Jack on his return from National Service. Mr Reid's visit to the U.S.A. coincided with the flush of spring work at Auchincruive, and his absence placed much extra responsibility on the staff.

LIBRARY AND PUBLICATIONS

Publication of the first annual report was considerably delayed because many details concerning subject matter and format needed careful thought.

It is hoped that future reports will appear soon after the close of the adminstrative year in March.

The library is now housed in the largest available room in the new building and its administration has been entrusted to a staff committee under the chairmanship of Dr Cadman. Increased staff, with consequent demands for a wider range of periodicals, have strained the library's slender finances, and gifts of periodicals and reprints have been particularly welcome. The committee is especially indebted to Dr W. M. Dickie, Librarian of Queen's College, Dundee, for the gift of a useful run of "Nature."

OTHER ACTIVITIES

During the year the Institute received visitors from Holland, Norway, Cyprus, Canada, Finland, Australia, the U.S.A. and Denmark. We were particularly glad to welcome Dr F. O. Holmes of the Rockefeller Institute, New York and Dr K. W. Neatby of the Department of Agriculture, Canada. In August Mr N. H. Grubb, who has since retired from the East Malling staff, paid us his last official, but, we hope, by no means final visit. A special event was the visit on 6th July of the Scottish Horticultural Advisory Committee. This committee had much to do with the foundation of the Institute and four of its members, including the chairman, Mr Scarlett, are members of the Institute's present Governing Body. The summer meeting of Scottish advisory entomologists and pathologists was held at Mylnefield in August.

Grants from the A.R.C. enabled two members of staff to visit Holland during the year. Dr Wood's tour of the main horticultural research centres and fruit growing areas was kindly aranged by Dr Hester G. Kronenberg and he was able to spend some time at Wageningen viewing the newly erected physiological glasshouses at the Institute of Horticultural Plant Breeding. Mr Fisken attended the Second International Conference on Potato Virus Diseases held at Lisse and Wageningen in July.

The Institute's staff was much in demand for lectures during the winter. During his American tour Mr Reid gave several informal talks and at home spoke to growers in Worcester and Lanark, to the A.G.M. of the Nuclear Stock Association in London, and to the Horticultural Education Association in Darlington. Dr Cadman and Dr Wood took part in a successful Fruitgrower's Conference at Blairgowrie in December. Lectures on fruitgrowing problems were given by Dr Cadman in Wolverhampton and Hereford, by Dr Wood and Dr Guttridge at Ayr and Carluke respectively, by Mr Fisken at Dundee; and on vegetable growing by Mr North at Ayr and Carluke. Mr Reid, Dr Montgomerie and most of the Plant

Pathology Department staff attended the Jubilee Meeting of the Association of Applied Biologists in London in September, where the work on strawberry breeding and raspberry leaf curl disease was demonstrated.

A Growers' Day was held at Mylnefield on Saturday, July 24th, when some 50 visitors inspected the field experiments on fruit growing and vegetable culture.

COLLABORATION

The Director and Dr Wood continued to serve on the Scottish Fruit Trials Committee and Mr Reid on the Agricultural Research Council's Strawberry Diseases Committee and the strawberry sub-committee of the National Fruit Variety Trials. The Institute supplied canes of raspberry varieties for the new National Fruit Trials centre at Brogdale, Kent, and for the three Agricultural College centres of the Scottish fruit trials.

We have again many acknowledgments to make for gifts of seeds and plant materials, and for co-operation in connection with fruit and vegetable processing trials. Thanks are due especially to the Director of the National Fruit Trials, Mr J. M. S. Potter, for many contributions to the Apple Variety Collection over the past five years; and to the Horticultural Research Station, Long Ashton, the John Innes Horticultural Institution, the Royal Botanic Garden, Edinburgh, the Botanic Garden, Glasnevin, East Malling Research Station, and many centres overseas, for plants and seeds. Jam-making tests were carried out for us by the British Food Manfacturing Industries Research Association, Leatherhead, and canning tests by Messrs Smedleys Ltd., Dundee, Messrs Chivers & Sons Ltd., Montrose, Eastern Counties Preserves Ltd., Forfar and Mr R. W. McIvor, Crossford.

For help in the design of experiments and analysis of data grateful acknowledgment is due to the Statistics Section, East Malling Research Station, Mr Healy of Rothamsted Experimental Station, and Dr T. E. Faulkner of Queen's College, Dundee.

Throughout the year informal contacts were maintained with many members of the Scottish Department's Agricultural and Horticultural Inspectorates and with the staffs of the Scottish Agricultural Colleges.

Farm and Plantations

L. S. Gray

Last year's rainfall, 34.14 inches, was unusually heavy for this district. The difficulties of harvesting fruit and farm crops were aggravated by the fact that rain fell on almost every day during the harvest period. However, thanks to the efforts of all the staff concerned, fruit crops were gathered with little loss and hay and grain were harvested in good condition.

FARM SECTION

Yields from the 76 acres of grain crops were surprisingly high; 35 acres of Sun II. oats, half from imported Swedish seed, gave 2 tons per acre, and 20 acres of barley over 2 tons per acre. The barley was sold for malting and all grain straw surplus to feeding and bedding requirements was composted for use by the Vegetable Culture Department. Thirteen acres of sugar beet yielded just over 11 tons per acre, 2 tons above the Scottish average, and the crop had a sugar content of 16.92 per cent. The potato acreage has been reduced to an area sufficient to provide working material for the Plant Pathology experiments on potato virus diseases. The root crop, grown to provide winter cattle food, bulked well and gave a small surplus for sale.

Eighty head of Irish bullocks were fattened during the year, 34 during winter and the rest entirely on grass pasture. Trade was poor in spring, 1954, owing to the termination of official grading and buying. However, the cattle realised 17 per cent. more than cost price; and they had been fattened entirely on the produce of the farm and had provided some 200 tons of dung. Following the acquisition of Bullion Farm, winter fattening of cattle was transferred there and the two cattle courts at Mylnefield were converted into implement and other stores.

Much saving on repairs and on the building of experimental equipment has been effected by establishing a farm workshop in charge of a skilled mechanic. Its potential usefulness is limited by shortage of equipment.

FRUIT AND VEGETABLE SECTION

The weather in 1954 made plantation work difficult and costly, much work normally mechanised having to be done by hand. Moreover, many of the older experimental plots now require more attention. During the winter of 1954/55 the apple variety collection was enlarged and a small trial of sweet cherry varieties planted. Spraying for the control pests and diseases in the fruit plantations was carried out according to a programme prepared by Dr Wood and Mr Fisken.

The soft fruit crop was almost double that of 1953, and included some 21 tons of raspberries and 2 tons each of strawberries and black currants. Half the raspberry crop was sold for export to the U.S.A., packed in 40 lb. cans as separate varieties.

Twenty acres of cabbage were specially grown as part of a co-operative project with the Ministry of Food Experimental Factory, Aberdeen, concerning dry matter content and loss of vitamin C during processing and storage. The varieties were Greyhound, Early Ironside, Winnigstadt, Rearguard, Cotswold Queen, January King and Omega. Supplies of individual varieties had to be delivered at specific times, a difficult commitment in such an adverse season. The results of the year's work are not yet known.

GLASSHOUSE SECTION

Expansion of the scientific staff and the construction of additional glasshouses and frames have made increased demands on this section. It now handles a great variety of experimental crops and provides an indispensable service, particularly to the Plant Pathology and Crop Physiology Departments.

GENERAL

The increasing extent of field experimental work has made it essential to keep a detailed record of the annual use of land. This is being done in map form by the Pomology Department. The urgent need for shelter from the damaging winds to which Mylnefield is subject is being met by planting windbreaks. Those planted in 1953 and 1954 are now well established. In spring 1955, a beech hedge and a line of black poplars were planted west of the glasshouse block, and plantings of black poplars and *Chamaecyparis Lawsoniana* were made in School Field to protect the fruit trees there.

A major task this year was the distribution, in spring 1955, of some 35,000 runners of the new strawberry variety Talisman, propagated in two stages at Mylnefield from plants received from Auchincruive in 1953. Although the release of virus tested nuclear stocks of raspberry was temporarily in abeyance, some 7,000 canes from healthy stocks were sold during the winter, mainly for propagation. From new cane nurseries established during the spring it is hoped to resume the production of stocks eligible for planting for Special Stock certification.

Pomology

C. A. Wood

Despite staff changes, the year was mainly one of useful progress. Acknowledgment must be made of the good work of the Plantations staff in handling field experiments and trials occupying some 25 acres, during an exceptionally difficult season. Co-operation continued with other departments, particularly in the routine control of pests and diseases and the production of raspberry nuclear stocks.

THE CULTIVATION OF RASPBERRIES

Experiments on the influence of cultural factors in raspberry growing, described in the previous annual report, form a main part of the programme and require intensive maintenance and recording both in summer and winter. In the field experiment on distances of planting and heights of cane-tipping, the widest rows (8½ feet apart) again gave the highest yield of fruit per stool, but the narrowest (5½ feet apart) the highest per acre. This result was very highly significant ($P = 0.001$) but, in contrast with previous years, the inter-stool spacings (2, 2½ and 3 feet) within the rows had no significant effect. There was merely a slight tendency for the most closely planted rows to give, as usual, the heaviest crop. An excessive number of fruiting canes was carried throughout this experiment during the year, and any effect of inter-stool spacing was probably suppressed by the overcrowding. The fruiting canes in 1954 were tipped at 4¼, 4¾, or 5¼ feet, three inches higher at each level than in the previous year. Each increase of height gave a very highly significant crop increment, a result more clear-cut than that of 1953; but much fruit on the canes tipped at 5¼ feet was beyond the convenient reach of pickers. The heights for 1955 have therefore been reduced to 4, 4½ and 5 feet.

The experiment comparing the planting of canes singly with planting in pairs ("double" planting) again gave a very highly significant difference in yield per acre in favour of the double-planted plots. This was true in all four varieties (Malling Promise, Malling Jewel, Lloyd George and Norfolk Giant) and showed that the effect of double planting had persisted for two years beyond 1952, the first year of the experiment. Winter records in 1954/55 later showed that all the varieties except Malling Promise still carried larger numbers of potential fruiting canes on double than on single-planted plots. On all plots of Malling Promise and Norfolk Giant the cane numbers were excessive by normal standards and were reduced to a common average of 7 per stool: but in Lloyd George and Malling Jewel they were within the normal range. It is possible, therefore, that these two varieties

will again show the advantage of double planting in their 1955 crop. It will be necessary in later years to note whether the double-planted stools develop any special faults—such as a more rapid deterioration in cane quality—to offset their earlier good performance.

In the third experiment of the series, plots of Malling Promise and Lloyd George picked at 2-3 day intervals again produced significantly higher yields ($P = 0.05$) than those picked at the 4-6 day intervals usual when growing for the jam market. This result has now been obtained for three years. Treatments varying the average number of fruiting canes retained per stool were applied for the first time in 1954, the numbers chosen being 3, 4, 5 and 6. Very highly significant increases of yield ($P = 0.001$) were obtained as the cane numbers increased from 3 to 5 per stool, but 6 canes gave no further increase.

Another experiment planted in 1952 compared the subsequent establishment and growth of canes lifted from a nursery at different times in the dormant season. Late-dug canes are said to be apt to fail, but in some seasons and districts delay is often unavoidable. Samples of 100 canes of Malling Promise were lifted at monthly intervals from November to April and all planted in mid-April, taking normal precautions against drying. The number of failures was negligible, and by autumn 1953 the experiment was virtually uniform in growth. This result will require confirmation under varying conditions, however, to be regarded as firmly based. The experiment is now being used for a comparison between normal winter tipping of canes and the alternative of "boughing-over" the tops and tying them down to the upper wire. Untreated plots, with the tops free and untipped, are also included. In 1954 the boughed-over and untreated plots out-yielded the tipped but were difficult to pick and more subject to wind damage.

The new experiments previously reported on distances of planting and methods of training became well established in 1954 and should receive their full range of treatments in 1955/56. Plans were made for a group of smaller, "intensive" experiments to be planted in 1955 in the new fruit cage. These will seek to interpret some results of the field experiments in detailed terms of plant growth, such as the number and size of canes, fruiting laterals and fruits. Preparations were also made to investigate the growth and development of the individual raspberry plant by a method of growth-analysis.

(C. A. Wood, H. M. Robertson, M. E. Acheson and M. M. Anderson.)

RASPBERRY BREEDING

In completion of earlier work, a further season's records were taken from the trial of varieties and East Malling seedlings at Kirriemuir and a semi-popular account was published of the five years' results.[1] The trial of

more recent Malling seedlings at Mylnefield gave further data on growth and yields, and samples of fruit were submitted for canning and jam-making tests.

In the Mylnefield breeding programme thirteen more crosses and self-pollinations were made, comprising four crosses between varieties of red raspberry, five between raspberry and other *Rubus* species, and four self-pollinations of species of *Rubus*. Some 7,000 seeds were sown in the autumn. The next two years will largely be occupied with initial selection work on the families raised since 1952.

Further additions were made to the collection of *Rubus* species—and also to that of *Ribes*, in preparation for work on black currant breeding. It is proposed to make botanical studies of these collections and employ for breeding purposes any species that seem to have desirable characters.

(C. A. Wood, H. M. Robertson and M. M. Anderson.)

STRAWBERRY INVESTIGATIONS

With the completion of Mrs Robertson's studies on flower and stolon formation and the transference of Dr Guttridge's work to the department of Crop Physiology, strawberry investigations in Pomology now comprise (a) the continuation of field observations on "June Yellows," (b) performance trials of stocks and selections of Auchincruive Climax and Royal Sovereign, and (c) trials of new seedling selections from Auchincruive.

Records of June Yellows were taken on all experiments containing Climax but chiefly on a replicated trial, planted in spring 1953, comparing ten sub-clones of the commercial clone A49 (see also West of Scotland Unit report). These had been tested and found free from virus infection at Auchincruive in 1951, but later developed marked differences in yellows expression. By mid-April, 1954, one sub-clone had become uniformly stunted, with severe symptoms of the "streak" type, whereas another was still almost normal; only on close inspection were slight yellows symptoms found in three of its sixty plants. All available runners of this green sub-clone were therefore planted for propagation, but on inspection in mid-June some 16% of the plants showed yellows of the "transient" type. (Observations in 1955 indicate a further marked increase of yellows in this sub-clone).

Samples of several Scottish stocks of Climax officially certified in 1954 (and therefore substantially free from yellows on inspection) will be planted in 1955 for observation and possible selection, and runners from green selections seen by the writer in Holland in June, 1954, have been imported for the same purpose. Among Scottish stocks, however, June Yellows appears to be increasing, and it is felt that any improvement gained by field selection is likely to be short-lived.

Collaboration with the Auchincruive unit in the trial of new strawberry selections was extended in 1954 with the planting at Mylnefield of 4-plant blocks of some 90 seedlings raised between 1948 and 1951. Previous trials had included only a few selections, already at an advanced stage of test. The aim of this work is to obtain early information on the performance of promising seedlings in an area considerably different in climate from the West.

Use is being made of certain strawberry trials at Mylnefield to study the effect of summer defoliation on the following season's cropping. Removal of the leaves of Climax from a small trial in August, 1953, led to a greater production of inflorescences in 1954 and a considerable increase of crop. The plants were then in their second cropping season or third year of growth. This experiment, which is being repeated, is of interest in relation to the occasional tendency of Climax to become highly vegetative and unfruitful, generally in the second cropping year. The same treatment produced no significant effect on Royal Sovereign.

(H. M. Robertson, M. E. Acheson and C. A. Wood.)

APPLE AND PLUM VARIETY-ROOTSTOCK TRIALS

The purpose and design of these trials were described in the previous report. Of the 600 trees of the apple trials a number developed canker lesions, most but not all associated with hare damage shortly after planting. The majority recovered well, but one (King Edward VII on M.XVI) was replaced in 1954/55 and replacements are being prepared for five others. These trees were grown unpruned in 1954 and headed back in January, 1955, to be formed as open-centre bushes.

The trial of plums, planted in 1953, sustained much wind damage in spring and early summer. This might have been less had the trees been grown as bushes instead of half-standards, but useful information has been gained on the relative wind-firmness of the varieties. A few trees were added to this trial in March, 1955. Plantings of black poplar and *Chamaecyparis Lawsoniana,* designed to shelter this trial and nearby apple plantations, were completed in the spring of 1955.

(M. M. Anderson, W. Fordyce and J. P. Sutherland.)

SCOTTISH FRUIT VARIETY TRIALS

The trials at Mylnefield of strawberry, raspberry, black currant and plum varieties were continued in co-operation with the Scottish Fruit Trials Committee. General progress was satisfactory and cropping good, that of Lloyd George raspberry being outstanding at almost 7 tons per acre. These trials, except the plums, which are younger, were planted in the spring of

1952. Reports from the three Agricultural Colleges and Mylnefield provided the basis for a recent First Progress Report (Hall, J. W. (1955)—*Scottish Agriculture, 34,* 222-224).

The apple variety collection on M.IX rootstock has now reached the stage at which varieties are beginning to show clear differences in growth-vigour, habit, and times of blossoming and leafing. More than fifty fruited in 1954 for the first time. A fairly good apple season in the Carse of Gowrie provided an opportunity to examine and mark many orchard and garden varieties, several of unknown or doubtful indentity, for future addition to the collection. Ninety-two varieties collected in previous years were added early in 1955, bringing the total in the collection to about 460. Nine varieties in the apple variety "elimination" trial fruited in 1954 for the first time, and some additions were made to this trial also.

In March a small trial of Sweet Cherries was planted, using a set of 40 trees supplied by East Malling Research Station. Few cherries, other than wall trees, can now be found in the Carse of Gowrie, but there is past experience to suggest that they may succeed. The trees now planted, standards on F12/1 rootstock, consist of eight of each of the varieties Early Rivers, Merton Heart, Merton Bigarreau, Napoleon Bigarreau and Géante d'Hedelfingen.

(M. M. Anderson, W. Fordyce and J. P. Sutherland.)

PROPAGATION OF VIRUS FREE RASPBERRIES

In co-operation with Plant Pathology, trial was begun of a method of propagating virus free raspberry stocks from root cuttings inserted in bushel-type boxes in an insect-proof gauze-house. By transferring the mass of roots formed in the boxes into isolated shallow beds out-of-doors a year later, it is hoped to obtain a crop of canes in the open in one year, instead of the two years required for a normal cane nursery. The method is experimental and may not succeed quantitatively; but it is an attempt quickly to multiply a small quantity of valuable material into a stock of workable size with least danger of re-infection.

(C. A. Wood and M. M. Anderson.)

MISCELLANEOUS

Further additions were made to the collection of red currant varieties. Many of these, and some blackcurrants of overseas origin, were propagated in preparation for planting in 1956.

Routine plantation spraying was carried out in accordance with a prepared programme (see Farm and Plantations report). A satisfactory control of Raspberry Beetle—at present the most troublesome pest in the planta-

tions—was obtained with a single application of derris wash at the rate of 200 gallons per acre when the first flowers were opening. The spraying of raspberry stools in late winter with an 8% tar oil wash, precautionary against Raspberry Moth larvae, gave a useful control of annual weeds.

Publication.

1 WOOD, C. A. (1955). Fruit Variety Trials—2. A Trial of Raspberry Varieties and Seedlings at Kirriemuir, Angus. *Scottish Agric., 34*, 161.

Vegetable Culture

C. North

During 1954 all the vegetable experiments were grown in a 5-acre section of East Loan field. This concentration facilitated soil preparation, cleaning and bird control. In the spring, however, a permanent site for the main vegetable experiments was chosen in South Bullion field, providing for a three year rotation of 12-15 acres per annum. The area was sown to barley and wheat. After harvesting it was surveyed for levels and divided into strips which take full advantage of the contours. These strips are 400 yards long, alternately 100 and 120 ft. wide, and orientated NNW to SSE.

FRENCH BEAN VARIETY TRIALS

A trial was made of 7 varieties of French bean selected for high yield and canning qualities from 39 varieties grown in 1953. Owing to the abnormally cool summer conditions growth was slow, and a ground frost on 18th September terminated harvesting of the plants at an early stage of development. The Danish variety, Record, and the Dutch variety, Double Princess, gave as high yields as the control variety Masterpiece. Refugee gave a negligible yield because of its lateness. The pods of most varieties were misshapen, but those of Record and Refugee were straight and of good shape. Pods of some varieties became slightly stringy as they aged; Record was better than Masterpiece in this respect but poorer than other varieties in the trial.

(C. North and L. Frith.)

SPINACH VARIETY TRIALS

From 38 varieties of spinach grown in 1953, 7 were selected for further trial. In 1954 two similar replicated trials of these 7 varieties were sown, one on 2nd April and the other on 29th June.

In order that varieties might be compared at an equivalent stage of development, frequent counts were made of the percentage of bolters. Varieties were harvested when 15-20% and 25-35% of plants in the early and late sown trials respectively had commenced to bolt. Although these stages were chosen arbitrarily an attempt was made to relate the percentage of bolters to the optimum time for havesting.

The highest yields were given by two strains of King of Denmark, one from Sweden and the other from Holland, and by a Dutch variety, Troubadour; these three strains were also the latest to bolt. Early-bolting strains gave the lowest yields. The best strain took 65-75 days from sowing to harvest and gave yields of over 7 tons/acre, showing that good crops of spinach can be grown in Scotland provided suitable strains are chosen.

(C. North and L. Frith.)

PEA VARIETY TRIALS

A replicated yield trial of peas sown in 1953 gave no useful results because of excessive bird damage and difficulties in shelling the pods and in assessing when the varieties were ripe for harvesting. The 1954 trial was therefore sown in an area where birds could more easily be controlled; a shelling machine was purchased; and the maturity of shelled peas was measured by the Alcohol Insoluble Solids Content test. A 'Texturemeter,' presented by the Kellogg Trust, was also used to measure ripeness. Measurements with this instrument varied a great deal according to whether the peas were hand - or machine - shelled, and there was no useful correlation between its readings and the data from the A.I.S. tests.

Despite the cold, wet season, the crop grew well and relatively high yields were obtained. Unfortunately the rate of maturation of some varieties was slightly misjudged so that all were not harvested at the Practical Canning Stage (taken as 13.5% alcohol insoluble solids). Canner's Perfection and Lincoln gave the highest yields. The former yielded 83 cwt. shelled peas per acre, but had it been harvested at the 'correct' stage it would have given 92 cwt./acre.

(C. North and L. Frith.)

BRUSSELS SPROUT VARIETY TRIALS

Whereas two trials of brussels sprout — one on behalf of the National Institute of Agricultural Botany—were conducted in 1953, a single trial of 11 varieties, with 6 replications, was grown in 1954. The cool 1954 summer was followed by several weeks of exceptionally cold weather in the early months of 1955, and yields of marketable sprouts were much reduced by the combined effect of poor growing conditions and severe frost damage.

For the third successive year Harrison's XXX and Ashwell's strain gave the lowest yields. There was little difference in the yields of marketable sprouts from Cambridge No. 1, Cambridge Special, Evesham Special (Tozer) and Masterman (Finney). Cambridge Special gave the highest yield of first-class sprouts, but these were small and difficult to pick. Evesham Special sprouts were a much better colour than those of Masterman or Cambridge No. 1. A full report on the three years' trial will shortly be published.

(C. North and L. Frith.)

VEGETABLE BREEDING

One hundred and twenty-two inter-varietal crosses of cabbage and brussels sprout were made with material selected in 1953. The plants were flowered in a heated glasshouse and seedlings were raised from a few of the crosses. Owing to the cool summer and the comparatively small size of the seedlings when they were planted in the field it was not possible to assess the F_1 lines adequately. However, the hybrid lines all produced 'heads' or 'sprouts' and appeared uniform in vegetative characters: plants were selected from them for selfing and back-crossing.

F_1 plants, and vegetatively propagated plants from strains not hitherto used in the breeding programme, were taken into the glasshouse in January. These plants were employed to give F_1, F_2 and backcross progenies.

(C. North and G. Priestley.)

PHYSIOLOGICAL INVESTIGATIONS

Studies on the growth and development of the cabbage were continued. These mainly involved growth analyses and microscopical examinations of growing points, but some effects of grafting, shading and artificial illumination were also observed.

The results suggest that the 'head' of the cabbage does not consist of additional leaves but results from the failure of a proportion of the normal complement of leaves to unfold. A study of 'heading' is therefore essentially a study of the factors influencing the unfolding of leaves. The work so far has shown that, whereas all leaves have the capacity to unfold when they are formed, successive leaves gradually lose that capacity. The nature of the factor or factors inhibiting unfolding will be investigated further. Rosette rogue plants of January King do not differ from normal plants in the number of leaves they form, nor in the length of internodes, but in such plants the unfolding of leaves is not inhibited. There is some evidence to show that the lack of inhibition of leaf unfolding in rogue plants may be related to an early changeover from the vegetative to the reproductive phase.

(C. North.)

Crop Physiology

T. Swarbrick

This department, created in November, 1954, is staffed by Dr G. L. Hodgson and Dr C. G. Guttridge (formerly of the Horticultural Botany Department), assisted part-time by Mr J. Sunderland, the Institute's meteorological officer and photographer. Dr Guttridge is continuing his work on growth habits of strawberries and Dr Hodgson is investigating the role of climatic factors, peculiar to Scotland, in the culture of outdoor and glasshouse crops.

The Growth Habit of the Strawberry in Relation to the Environment

EQUIPMENT

Progress in this field is governed to a considerable extent by the means available for the maintenance of a predetermined climatic environment. An important achievement of the year, therefore, was the purchase and adaptation as growth cabinets of two second-hand butcher's cold-storage rooms. Each room has a capacity of approximately 240 cu. ft. and accommodates 40 strawberry plants in 5in. pots. A combination of fluorescent and tungsten-filament lamps was installed in the cabinets and provides sufficient light to maintain satisfactory plant growth. The heat output of these lamps is removed and a thermostatically controlled temperature is maintained by direct-expansion refrigeration units. Owing to restricted cooling capacity the first cabinet can be used only at temperatures above 50°F (depending on the ambient temperature) unless the light intensity (c.900 f.c.) and hence the heat input is reduced. A larger refrigeration unit has therefore been fitted in the second cabinet making it possible to maintain temperatures at any level between 25°F and 75°F, $\pm$ 1°, with a light intensity of about 1500 f.c. The rate of air change is adjustable. The first cabinet has been operating successfully since November 1954 and both are now in use (April 1955). The first experiment is not yet complete, but it is clear that the cabinets are functioning satisfactorily.

EXPERIMENTAL WORK

During the year further evidence has been obtained showing that Royal Sovereign, Auchincruive Climax and the "Perpetual" variety Kuntner's Triumph are facultative short-day plants initiating inflorescences sooner or more frequently in shorter daylengths. Additional "Perpetual" varieties are now being tested for daylength response. The response to daylength is, however, negatively influenced by temperature so that, within the

range encountered in summer, initiation of inflorescences occurs more readily as the temperature is lowered. Flower initiation in Climax in summer is a delicately balanced response and its frequent occurence in June (leading to the autumn crop) in contrast with its relatively infrequent occurrence in July can be attributed to the temperature effect, as the mean recorded temperatures for June are lower than those for July. Thus the daylength-temperature complex of the natural environment in June permits (or induces) flower initiation but is inhibitive (or non-inductive) in July. In autumn, flower initiation takes place in many varieties under the influence of the relatively short days and lower temperatures. Autumn initiated flower trusses overwinter in the bud and flower the following spring.

The delicately balanced flowering response of Climax plants in summer provides the experimenter with a sensitive test system. Experiments with Climax at this time of year have shown that both the removal of spring flower trusses and the continuous removal of branch crowns during spring have an inhibitory effect on inflorescence initiation.

Climax plants that had received an experimental long-day treatment outdoors in autumn maintained a higher rate of leaf production, when grown in the glasshouse in December and January, than similar but untreated plants. Comparison with Sovereign plants, which do not rest so intensely, indicated that the long-day treatment of Climax had not prohibited the onset of rest entirely. Apparently neither long-day treatment alone, nor, as previous work has shown, the provision of high growing temperatures, will eliminate the resting condition from the annual growth cycle, although both factors operating together are more effective.

(C. G. Guttridge.)

Publications.

GUTTRIDGE, C. G. (1955). Observations on the shoot growth of the cultivated strawberry plant. *J. hort. Sci., 30,* 1.

Plant Pathology

C. H. Cadman

RASPBERRY LEAF CURL

This year the work done is in three parts: the association of ringspot viruses with leaf curl in different localities, comparisons of ringspot viruses isolated from raspberry, sugar beet and weed plants, and the mode of spread of these viruses.

Raspberry plants with leaf curl symptoms were collected from 12 different localities in Angus and Perthshire, and the viruses transmitted from each plant to *Petunia* and *Nicotiana rustica*, using the nicotine sulphate technique described last year. No such viruses were isolated from symptomless raspberry plants, nor were any of the aphid-borne raspberry viruses transmitted to tobacco or *Petunia* by this method.

Ringspot viruses were also isolated from diseased Malling Exploit plants sent by Mr P. G. Allan from the N.A.A.S. raspberry trial at Bere Ferrers, Devon, and from Malling Promise and diseased *Anemone* plants sent by Mr F. A. Roach from the Bristol area. These are the first records of ringspot viruses in raspberry plants outside Scotland.

Viruses isolated from raspberry often differed in the symptoms they caused in various test plants, of which *Hyoscyamus niger* was ultimately found best. Leaf curl symptoms on plants of Malling Jewel, Norfolk Giant and other sensitive varieties are associated with many differing ringspot viruses, and different groups of viruses occur in different localities: sometimes more than one of these viruses were isolated from individual plants.

As some of the raspberry ringspot viruses cause symptoms in common weeds, plantations with leaf curl were searched for infected weeds. Ringspot viruses were isolated from 9 weed species found at one locality, but from fewer or none at others. Other ringspot viruses were isolated from sugar beet, and subsequent glasshouse tests showed that sugar beet is a host for nearly all the viruses from raspberry and weed species. It is not known whether the viruses from sugar beet or weeds can infect raspberry plants: these isolates differ among themselves and some cause different symptoms from the raspberry isolates in the usual test plants.

Field and glasshouse experiments with raspberry and sugar beet showed conclusively that plants became infected only when their roots were in contact with soil from diseased plantations. In the field, infection of raspberry and beet was prevented by growing plants in polythene bags of

sterilised soil, irrespective of whether the plants were exposed above ground or completely enclosed with 100 mesh nylon bolting cloth. We therefore suspect that these viruses are spread by some form of soil transmission.

(C. H. Cadman, J. Chambers.)

Preliminary work was done on the *in vitro* properties of some isolates.

(B. D. Harrison.)

OTHER RASPBERRY VIRUSES

Field experiments to determine the rate of spread of veinbanding virus in Lloyd George were continued. Too few infections occurred in 1953 to show whether control of aphids by Systox, Parathion or DDT decreased virus spread. Of the 19 plants that became infected, all but 4 were immediately adjacent to the infected stools planted out in spring 1953. The insecticide treatments were repeated this year and estimates of the populations of *Amphorophora rubi* before and after the two spray applications confirmed the results obtained in 1953. Systox again controlled aphids but the amount of virus spread in 1954 is not yet known.

Preliminary results were obtained from a trial, begun in 1953, where healthy plants of Lloyd George, Norfolk Giant, Malling Exploit, Malling Landmark and Malling Promise were inter-planted with virus-infected Lloyd George. These suggest that varieties differ greatly in their susceptibility to leaf spot, one of the components of the virus complex causing decline of Lloyd George. Of the 50 initially healthy plants of each variety, 25 each of Malling Exploit and Lloyd George, 15 of Malling Promise, 1 of Malling Landmark and none of Norfolk Giant were virus infected by spring 1954.

(C. H. Cadman, A. G. Fisken, K. S. Anderson.)

PRODUCTION OF VIRUS-FREE RASPBERRIES

Heat-treated stocks of Lloyd George and Malling Jewel were bulked up during the year, re-tested and found still to be virus-free. They produced sufficient roots to provide for the planting of a small field propagation plot this spring. Plants of Malling Promise, Norfolk Giant, Malling Landmark and Burnetholm Seedling have now been obtained free from all known viruses, and stocks are being multiplied from root cuttings under glass.

Experiments were made during the year with virus infected plants of Malling Enterprise and Malling Seedlings V and T, and with Norfolk Giant, Lloyd George and Malling Promise infected either with vein chlorosis, veinbanding, yellows or leaf curl viruses. The full results of these are not yet

known. Heat treatment is a valuable means of freeing raspberry plants from virus infection, but the year's results confirmed the conclusion that beyond a minimum exposure period of 8 days there is little correlation between increasing length of exposure and percentage of plants cured.

(J. Chambers.)

POTATO VIRUSES

The results of glasshouse experiments on the transmission of potato leaf roll virus by the aphid *Myzus persicae*, using *Physalis floridana* and *P. angulata* as test plants, confirmed those of Kassanis at Rothamsted but conflicted with those of Kirkpatrick and Ross at Geneva, New York. Under our conditions *P. floridana* was more susceptible than *P. angulata*, but neither readily became infected.

Records of the spread in 1953 of leaf roll and Y viruses in experimental plantings of potatoes at Mylnefield and commercial crops in Aberdeenshire and Angus gave useful preliminary data. At Mylnefield, the most striking results were those from a trial where rugose mosaic-infected King Edward plants were rogued from plots of healthy Majestic on either 20th June or 13th July. Virus Y spread as much in the plots rogued on 20th June as in the unrogued control plots, although *Myzus persicae* was not recorded at Mylnefield until early July (see below). A second experiment concerned times of planting in relation to spread of rugose mosaic and leaf roll. The first planting was made on 30th March and the others at three successive fortnightly intervals. Both Y and leaf roll viruses spread more in the planting made on 28th April than in those made earlier or later : and both viruses spread further from the infectors in the late April and early May plantings than in the March and early April plantings. In both this and the roguing experiment, however, plants near the leaf roll or rugose mosaic infectors became infected much oftener than those more distant. Tuber progenies from individual potato plants sampled at Mylnefield and elsewhere were often partially infected.

In 1954 the experiments at Mylnefield were repeated and many more field crops were sampled in Angus and Mid and East Lothian. The results are not yet known.

(C. H. Cadman, J. Chambers.)

POTATO APHIDS

The complementary work on potato aphids was concerned mainly with finding over-wintering sites of *Myzus persicae* in eastern Scotland and following the course of aphid infestation of potato crops in East Lothian and Angus.

During the winter of 1953/54, no *Myzus persicae* was found on green crops in Angus and Perthshire though eggs were found on peaches under glass in two localities. In the Musselburgh area, however, small numbers of the aphid were found throughout the winter on outdoor Brassica crops and on lettuce, carrot, turnip and cauliflower plants grown in frames. Populations on the crops in frames increased rapidly and alatae from these colonised neighbouring crops of early potatoes, spring cabbage, cauliflower and brussels sprout in early May. By mid-July nearby early and maincrop potatoes had populations of 1500 and 400 aphids per plant respectively. Such heavily infested crops were a feature of the Musselburgh area only, for crops 10 miles distant had negligible aphid populations in mid-July and even by mid-August carried only 20-40 aphids per plant.

In Angus and Perthshire alate *Myzus persicae* were first trapped on 24th July, but surveys of some 14 different potato crops in these counties showed that small numbers of *M. persicae* were present in the first week of July. Records from water traps at Mylnefield and several other centres in Angus showed that most alatae were caught during the first week of August. On the crops surveyed, populations of the aphid began to increase slowly in early August and, where the haulms were not killed by burning or by blight infection, reached their peak in the first or second week of September, when winged migrants were produced.

During the autumn and early winter of 1954/55 overwintering *M. persicae* were found on savoy cabbage, brussels sprout and broccoli at Mylnefield and on these and spring cabbage and winter lettuce at Musselburgh. By early March no aphids could be found at Mylnefield and very few at Musselburgh.

(A. G. Fisken.)

CABBAGE ROOT FLY

A trial of Dieldrin, calomel, Chlordane, BHC and DDT for the control of cabbage root fly in cauliflower showed that Dieldrin increased both the weight and number of marketable heads. The Dieldrin-treated plots produced a significantly greater number ($P = 0.05$) of marketable heads than the DDT-treated or control (untreated) plots and a significantly greater weight of heads than any other plots. The plants were puddled in a slurry of soil and insecticide before planting out. An examination of the roots after the crop had been cut showed that ony 8 per cent. each of the Dieldrin and Chlordane treated plants were slightly damaged, whereas 84 per cent. of the untreated plants showed severe damage.

(A. G. Fisken.)

Mycology

T. Swarbrick

The work of this Department was envisaged as complementary to that at Auchincruive. For this reason I undertook to direct and co-ordinate the research carried out by Dr W. R. Jarvis at Mylnefield and by Mr R. D. Reid and Dr I. G. Montgomerie at Auchincruive.

Investigations of the host-parasite relations of physiologic races of *Phythophthora fragariae* Hickman (the red core fungus) were begun at Mylnefield in 1954 with the object of elucidating the disease-resistance mechanism operating in strawberries attacked by this organism. Strawberry roots are infected by germinating cysts, the mycelium invading the root cortex. In resistant varieties, however, further development is inhibited in some way as yet unknown. Preliminary work on the interaction of host-parasite enzyme-substrate systems suggests that retardation or inhibition of the terminal oxidase systems is important. This work is being carried out in conjunction with that of Dr I. G. Montgomerie at Auchincruive and is to some extent complementary to the physiological and race-distribution mapping work of Dr C. J. Hickman of Birmingham University.

Subsidiary work has been started on the air spora of the experimental fruit plantations at Mylnefield with special reference to *Botrytis cinerea* Fr. (the grey-mould organism) and *Elsinöe veneta* (Burkh.) Jenk. (the raspberry cane-spot organism). Studies are being made on the life-cycles of these fungi with particular reference to sporulation, spore dispersal and infection phenomena as affected by local climatic and micro-climatic environments. In the case of grey-mould epiphytotics it is hoped to amass sufficient data to establish a reliable forecasting service as has been done, for example, for potato blight. Preliminary investigations have been made with the aid of a portable spore trap, taking samples of a few minutes' duration. While results obtained from this method have their value, it is known that the composition of air spora is profoundly affected by rapid changes in the environment, e.g. by rain showers, and it is therefore hoped to obtain more continuous records by the installation of a Hirst automatic volumetric spore trap.

In conjunction with the Pomology Department preliminary trials were carried out on the fungicide Captan against grey-mould of strawberries with distinctly promising results.

(W. R. Jarvis.)

West of Scotland Unit (Auchincruive)

R. D. Reid

Work this year was interrupted by the writer's visit to the U.S.A. for six weeks in May and June 1954. The trip was somewhat exhausting, involving over 10,000 miles of travel round the perimeter of the United States and a short trip into Canada. Numerous research centres at which strawberry work is in progress were visited, and the discussions with specialised research workers were greatly appreciated. Visits were also paid to commercial strawberry growing areas. Much useful information was gained and valuable contacts made. It was comforting, however, to find that, when viewed against the impressive background of the many extensive projects in America, our own more limited efforts needed no apology either in techniques employed or results achieved. Individual items of interest from the tour will be mentioned in the appropriate sections below. The visit coincided with the main rush of work both in field and glasshouses at Auchincruive; this entailed much extra responsibility for the staff, to whom, especially Mr Sutherland, credit should be given for coping so efficiently with the extra duties.

Strawberry Breeding

OBJECTIVES AND TECHNIQUES

The observation of methods adopted at many American centres, added to the first full year's working experience of the new facilities at Auchincruive, make this an appropriate occasion for a review of the objectives and techniques of the investigation. Since its inception, the strawberry breeding work at Auchincruive has been directed to the production of new varieties, commercially acceptable for yield and quality and highly resistant to red core root rot. The technique of field testing, used until recently, involved rejecting all non-resistant seedlings irrespective of any good qualities they may have had. The development of new physiologic races of the pathogen has introduced new and complicated problems and it is now apparent that none of the sources of resistance presently available can offer complete immunity to all races. It has been considered expedient, therefore, to select for development seedlings with a high degree of resistance to the ordinary, widely dispersed races, because in practice such seedlings will thrive even though they do not possess the complete immunity once considered essential. This problem of physiologic races was found to be much to the fore in the American work also, but none of the varieties currently used by American breeders offer any new source of genes for resistance.

The strawberry breeding programme now falls into two parts: (a) short term—the production of varieties suitable for early introduction; and (b) long term—the search for new sources of red core resistance. As a result of the extra facilities available and the development of new techniques, it has been possible to speed up the process of testing seedlings for resistance and thus to increase the volume of work on both these programmes.

In the short term breeding programme, where many factors have to be considered before final selection of seedlings, the bench test is proving of particular value. Seedlings are grown, in the first instance, in concrete benches filled with infected soil containing a mixed inoculum, and those which are highly succeptible may be discarded immediately, thus saving a year over the earlier method of field testing. The survivors can be passed on to more extended trials in the knowledge that they have a useful degree of resistance even if they are not completely imune.

In the long term programme the search for new sources of resistance has led to extended investigations among *Fragaria* species. Earlier work with the octoploid species generally accepted as the parents of our modern hybrid varieties showed that these were generally susceptible, but that there was variation within the species, a few strains or varieties apparently possessing some considerable resistance. The sources of resistance on which the breeding programme at Auchincruive became based for many years were (i) an obscure local Kentish variety believed to be "Frith," and (ii) the Amercian variety "Aberdeen." Subsequent work suggested that (a) the variety "Little Scarlet," generally considered a form of *F. virginiana,* and (b) one of the several forms of *F. virginiana* in our collection, both possessed some factors for resistance, and these plants have now been employed in the breeding programme for several years. There is also some reason to believe that, whilst most of the forms of *F. chiloensis* are susceptible, at least one in our collection has resistance factors.

In the light of these observations, opportunity was taken during the visit to America to acquire as large a collection as possible of seeds of the three octoploid species *F. chiloensis, F. virginiana* and *F. ovalis.* In work with species hybrids there can be no hope of suitable commercial varieties emerging in the first few years, and a method of testing to eliminate all red core susceptible seedlings at the earliest possible stage, irrespective of observations on other characters, is essential. For this purpose the second of the new testing techniques—the spore suspension-dip—seems best. This is discussed more fully below. During the year, Dr Montgomerie applied this method to families from all the new sources of resistance under consideration at the beginning of 1954, and made a start on the very large quantities of seedlings being raised from the seed collections obtained from America.

Another improvement in practice has followed the introduction of artificial illumination. Hitherto, when seeds were sown in August germination was troublesome. Only a small proportion germinated early enough for the seedlings to be transferred to boxes in September, and germination during the winter months was poor and the mortality among late germinating seedlings very heavy. To delay sowing until the following spring gave better germination but meant an unbalance in the distribution of work throughout the year. The use of mercury vapour lamps to supply additional illumination—for up to 12 hours per day—has resulted in steady germination and growth throughout the winter. Sowing may now be spaced over a prolonged period and a steady supply of seedlings obtained. As a further result of the use of this illumination a plant of *F. chiloensis* from Ecquador, which had consistently failed to flower, has been induced to produce several fruits.

FIELD WORK AND SELECTION

The rainfall at Auchincruive in 1954 was 47.94 inches, 10.28 above the ten years' average. Precipitation occurred on 238 days. Such continuous wet weather caused many practical difficulties in cultivation and weed control and increased the incidence of *Botrytis* rot of the fruit. Even more important was its effect on red core disease, the incidence of which was greatly intensified even in highly resistant varieties. In view of the very exacting conditions of 1954 it has been particularly gratifying to find that some selections, known to be slightly susceptible to certain races of the pathogen, have continued to grow vigorously even in heavily infected land. This encourages the hope that in the general run of more normal seasons such selections may continue to show a high degree of field resistance.

In addition to the release of the variety Talisman, described elsewhere in this report, steps have been taken towards the early release of further seedlings. Three have already undergone re-testing for virus content at Mylnefield and are in process of being built up prior to release, and a further five are under serious consideration for early development and release. All these selections have resulted from crosses made in 1945 and 1946, so they already have a useful background of testing. From more recent crosses selections have been made and are in various stages of test.

(R. D. Reid, A. M. Sutherland and K. C. McConnell.)

Mycological Investigations

PHYSIOLOGIC RACES OF PHYTOPHTHORA FRAGARIAE

Work continued on the indexing of isolates of *Phytophthora fragariae*, using eight varieties as indicators for the identification of physiologic races. These were Royal Sovereign, Huxley, Oberschlesien, Perle de Prague,

Auchincruive No. 6, Auchincruive Climax, Auchincruive No. 11 and American Aberdeen.

Thirty-two isolates are now in culture from ten varieties and thirteen localities. Not all have been fully indexed, but the host/parasite reactions already obtained indicate that there are at least three distinct physiologic races differing in their range of host varieties.

TESTING NEW SOURCES OF RED CORE RESISTANCE

A number of *Fragaria* species and varieties under consideration as possible new sources of resistance were selfed, and the percentage of resistant seedlings produced determined by inoculation with a zoospore suspension of the fungus followed by incubation for 14 days. The inoculum consisted of an isolate obtained from Huxley, pathogenic to Royal Sovereign but non-pathogenic to Climax. The following table gives the results obtained in 1954.

Parents selfed.	% resistant seedlings in progency.
Magoon	18
Cambridge 475	14
Avant tout	11
F. nilgherrensis	0
F. virginiana	10
F. elatior	1

BOTRYTIS FRUIT ROT

Three applications of Orthocide (Captan) 50 Wettable were made to a fruiting bed of Climax approximately 1/10th acre in size at fortnightly intervals, starting from 17th June. The bed was divided into six plots, three of which were treated and three left untreated. Observations were made on five dates between 12th July and 2nd August, and each time there was less *Botrytis* on the treated plots than on the untreated. The number of berries infected with Botrytis was from 4—26% less on the treated plots, and the reduction in the weight of diseased fruit varied from 3—24%.

(I. G. Montgomerie.)

"Yellows" Complex

It is now known that "June Yellows" has occurred in over 30 named varieties in the United States and has been responsible for the disappearance from commerce of some that were once well established. Others, such as Blakemore and Premier (Howard 17), have suffered severely, but by

rigorous and continuous re-selection "green" clones have been developed which have kept them in being. Discussions with strawberry breeders in America revealed that yellows is now a major problem in every breeding project and seems very far from being solved.

Interesting results have been obtained in recent work on the behaviour of ten sub-clones of Climax. These were derived from ten plants selected in 1950 as outstandingly healthy and showing all-round merit. They were found by graft testing in 1951 to be virus free, and all fruited well. The runners from each have been propagated separately each succeeding year, and the progressive rate of degeneration in each sub-clone has been very distinctive.

In 1952 symptoms of yellows were seen in sub-clone 2 and very slight traces in several other sub-clones. By 1954 all plants of sub-clone 2 were very poor and many had died. At the other extreme, sub-clone 7 has shown only a very mild form of transient yellows on a small proportion of the runners, and cropping has been up to the standard expected of a completely healthy stock. The other eight sub-clones have shown a range of symptoms varying between these extremes. It is appreciated that individual plants or even the whole stock of sub-clone 7 may develop yellows symptoms in the future, but this stock has nevertheless remained as a profitable commercial proposition for several years longer than sub-clone 2. These observations have given a striking demonstration of the dangers that may accompany the building up of a large stock from a single plant, a procedure that has been much in use as a consequence of virus testing techniques developed in recent years.

Critical observations on the occurrence of "yellow" seedlings in batches of breeding material have been facilitated by the better growth obtained under mercury vapour lamps. The relatively frequent occurrence of chlorotic seedlings and the greater ease of their recognition suggests that the extra illumination may have had some effect in inducing the expression of latent symptoms of yellows in many phenotypes. Progeny-testing, whereby the proportion of yellow seedlings occurring in a family is taken as a means of forecasting the liability of a parent variety to mutate to the yellow condition, has become accepted practice in America and been advocated in this country also. Our observations this year, however, throw some doubt on its value, at least in our present state of knowledge. The occurrence of yellow seedlings is both frequent and general. Seedlings may have yellow cotyledons when they emerge above ground, in which case they usually die at an early stage. In many other instances seeds germinate with normal green cotyledons and develop "chlorotic variegations" in the first true leaf or at any subsequent stage. The occurrence of yellow or white

variegation in seedlings at any stage before they produce stolons has been taken as an indication that the parent variety carries the latent yellows factor: but our observations at Auchincruive throw doubt on this prognostication for the following reasons:—

(a) With varieties like Climax, known to be yellows-prone, the proportion of yellow seedlings produced is related to the degree of development of the condition in the parent plant. Thus, when "persistent yellow" plants of different varieties were selfed almost 100% of the seedlings showed variegation within a few months of germination, whereas green plants of the same varieties gave much lower proportions of yellow seedlings.

(b) Under mercury vapour lamps yellow seedlings were observed in all batches, even when these were raised by the selfing of varieties which have never been known to show the yellow condition. In this year's work, yellow seedlings have occurred in families raised from selfed plants of such "green" varieties as Huxley and Oberschlesien, and from selfed plants of various species including *F. virginiana, F. elatior* and *F. chiloensis* (seed of the last-mentioned obtained direct from Chile).

The often-accepted thesis that this latent tendency to produce "yellow" mutations is limited to a few varieties is therefore open to serious doubt. The precise significance of variegated seedlings is as yet uncertain: many have been retained in order to observe their future development.

(R. D. Reid, A. M. Sutherland, K. C. McConnell.)

Raspberry Breeding

A further series of crosses was made in 1954 in the raspberry breeding programme, which aims at the production of high yielding varieties of suitable fruit quality for the fresh fruit and processing markets and adapted to the climatic conditions of the West of Scotland. A large number of seedlings from crosses made in 1951 and 1952 are growing in their fruiting quarters in the field and seedlings from 1953 crosses were planted out in spring, 1955. The selection made from one of the 1946 crosses gave very satisfactory results in 1954, and steps have been taken to multiply virus free plants with a view to its possible introduction to commerce in the near future.

(R. D. Reid, A. M. Sutherland, K. C. McConnell.)

The New Strawberry Variety "Talisman"

R. D. Reid

This variety, introduced by the Institute in the spring of 1955, was raised at Auchincruive as a selection from a cross made in 1946. The seed-parent was an unnamed seedling of American origin and the pollen-parent Auchincruive Climax.

During its trials Talisman was known as 6J4. It was grown in the National Fruit Trials at Wisley, and at Mylnefield as well as at Auchincruive. Originally bred for resistance to red core disease, it is, like Climax, immune to the ordinary races of the fungus but susceptible to special physiologic races.

Little is yet known of its reactions to virus diseases; the runners distributed were raised from virus tested plants and distributed as an elite stock. Up to the time of distribution no June Yellows was observed in the stock, but owing to the unpredictable nature of this condition no indication can be given of the possibility of its future appearance in this or any other variety.

In trials at all three centres Talisman has cropped consistently well, even more heavily than Climax. At Auchincruive, where it has been fruited every year since 1948, cropping has always been satisfactory. The season is the same as that of Climax (late main crop) and the two varieties are also similar in times of flowering, although spring growth starts slightly earlier in Talisman.

The fruit is quite firm in texture and appears to stand up well to transport, making it suitable for the fresh fruit market. The colour is deep scarlet, tending to darken in fruit that is allowed to stand, and the flesh is more deeply coloured than that of Climax. In flavour it is considered by most people to surpass Climax, being sweeter. Small-scale jam-making and canning tests by commercial firms have given satisfactory results but quick-freeze tests have not yet been made.

The following is a description of the variety:

Plant: Strong, vigorous grower; very upright and compact in habit and growth.

Lamina: Medium to large; medium green; surface flat to concave.

Leaflets: Flat to concave; slightly longer than broad, base angle slightly obtuse; slightly rounded. Marginal serrations medium coarse, fairly sharp, medium depth, slightly rounded. Hairs on leaflets fine and few.

Petiole: Short to medium length, narrow; channel very slight; colour green, occasionally tinged red. Hairs outright, long.

Stipules: Large, broad; green in spring, becoming reddish as season advances.

Runners: Numerous, vigorous, green, occasionally tinged red; hairs upright, short.

Inflorescence: Compound, usually breaking twice; peduncle sturdy, hairs outright, long; pedicel hairs short, upright.

Flower: Small to medium size; complete. Petals small, length greater than breadth; calyx occasionally double, sepals long, narrow, downy. Stamens numerous, filaments long.

Fruit: First fruits long wedge, occasionally ridged, apex symetrical;—unlike Climax where apex is characteristically oblique.

Later fruits long conical, with blunt apex.

Achenes yellow or red, embedded, but surface of fruit not pitted; remains of pistils persistent on achenes.

Colour deep scarlet, becoming dark, glossy. Flesh light red, suffused white. Plug small. Calyx not very easily removed in earliest fruits but becomes easier as season advances. Texture of flesh firm, skin not readily bruised. Flavour very pleasant, sweet to sub-acid.

Season of ripening, late main crop: lasts about four weeks.

Meteorological Records

C. North and J. Sunderland

In 1953 the Vegetable Culture Department undertook the responsibility of setting up an officially recognised meteorogical station at Mylnefield. A suitably exposed site was chosen according to the Meteorological Office recommendations for weather stations. This lies almost due north of the glasshouse unit and is 100 ft. above mean sea level — the highest point on Mylnefield and Bullion. The area was turfed and the following instruments were installed:

Campbell-Stokes sunshine recorder;

Standard rain gauge;

Stephenson screen with maximum, minimum and wet and dry bulb thermometers, thermograph and hygrograph;

Grass minimum thermometer;

Earth thermometers at 4 ins., 8 ins., 1 ft., 2 ft. and 4 ft.;

Wind vane;

Soil tensiometer.

Daily recording commenced on 1st January 1954, the time of observation being 0900 G.M.T. At first the readings were made by the Vegetable Culture Department, but after a short training period the Glasshouse staff undertook the work. In June one of us (J. S.) assumed responsibility for all meteorogical records.

In addition to the main site, five smaller sites were established at selected points on Mylnefield to measure the soil and grass minimum temperatures. The purpose of these sites is to survey the temperature distribution at Mylnefield, and eventually at Bullion, and thus provide preliminary information to assist in the siting of experiments.

Results obtained at the main site for the calendar year 1954 are summarised in the following tables:

Meteorological Records at Mylnefield, 1954

Month	TEMPERATURE. °F Average (1) monthly	TEMPERATURE. Deviation from mean (2) 1921-1950	RAINFALL in.	RAINFALL Deviation from mean (2) 1881-1915	SUNSHINE hrs.	SUNSHINE Deviation from mean (2) 1881-1915
Jan.	37.3	—0.2	1.51	—0.43	44.6	— 8.4
Feb.	35.4	—3.1	2.44	+0.61	64.4	— 11.0
March	39.0	—2.2	2.11	+0.23	65.1	— 39.7
April	44.5	—0.3	0.95	—0.66	192.1	+ 52.8
May	50.0	+0.6	5.07	+3.08	176.0	+ 9.2
June	52.9	—2.4	2.01	+0.34	80.3	—103.0
July	55.9	—2.9	3.06	+0.51	162.1	+ 8.0
Aug.	55.7	—2.2	2.48	—0.79	107.0	— 33.8
Sept.	50.6	—3.4	2.21	+0.20	130.9	+ 9.0
Oct.	48.9	+1.0	5.18	+2.58	94.1	— 40.5
Nov.	40.3	—1.4	3.96	+1.64	58.0	— 5.0
Dec.	40.7	+0.3	3.16	+0.64	43.7	+ 2.8
Year	45.9	—1.3	34.14	+7.95	1218.3	—159.3

(1) Computed from daily mean of max. and min. temp. at 0.900 G.M.T.
(2) Recorded at official Dundee station.

The weather during the growing season in 1954 was distinctly colder, wetter and less sunny than usual. Especially cold weather conditions obtained in June, July and August. In May the rainfall was well in excess of the average, and June was markedly sunless. These adverse conditions led to delayed ripening of many crops and considerably less summer growth than usual.

HARLEY & COX
Printers Ltd
21 North Tay Street
DUNDEE